OPTIMIZATION OF CUTTING PARAMETERS AND SURFACE ROUGHNESS ON DRY TURNING OF LOW CARBON STEEL

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ABSTRACT

Cutting fluid play a very important role in machining but it also brings a lot of detrimental effects such as health hazards and environmental pollutions when it handled improperly. In addition, the cutting fluids also increase the amount of machining cost since it had been issues lately of its cost frequently higher than the cost of cutting tools. With this issue, dry machining becomes one of the solutions to solve this problem. The objective of this project is to optimize the cutting parameters and surface roughness on dry machining. Material chosen to be perform in this study is low carbon steel AISI 1019. The experiment is carried out with a full factorial design of 3 cutting parameters with 3 levels each onto dry Lathe machining. The surface roughness of workpiece is measured by using perthometer and the result is analyzed statistical by using STATISTICA software version 7.1. The optimum cutting parameters and surface roughness can be investigated through the ANOVA prediction with a level of confident 95 percent. The result investigate can help the industries to solve the problem by applying the investigated values of parameters not only in reducing the machining cost but also present a more environmental friendly machining operation.

ABSTRAK

Cecair pemotongan memainkan peranan yang amat penting dalam pemesinan tetapi ia juga membawa banyak kesan yang memudaratkan seperti masalah kesihatan dan pencemaran alam sekitar apabila ia dikendalikan dengan tidak sesuai. Di samping itu, cecair pemotongan juga meningkatkan jumlah kos pemesinan kerana ia telah menjadi isu sejak kebelakangan ini kos ia yang kerap melebihi kos alat pemotong. Dengan isu ini, pemesinan kering menjadi salah satu penyelesaian untuk menyelesaikan masalah ini. Objektif projek ini adalah untuk mengoptimumkan parameter pemotongan dan kekasaran permukaan pada pemesinan kering. Bahan yang dipilih untuk melaksanakan kajian ini adalah keluli berkarbon rendah AISI 1019. Eksperimen dijalankan dengan reka bentuk faktoran penuh daripada 3 pemotongan parameter dengan 3 tingkat setiap parameter ke pemesinan kering Larik. Kekasaran permukaan benda kerja diukur dengan menggunakan perthometer dan hasilnya dianalisis statistik dengan menggunakan versi perisian Statistica 7.1. Parameter pemotongan optimum dan kekasaran permukaan boleh disiasat melalui ramalan ANOVA dengan tahap yakin 95 peratus. Hasilnya menyiasat boleh membantu industri untuk menyelesaikan masalah dengan menerapkan nilai-nilai yang disiasat parameter bukan sahaja dalam mengurangkan kos pemesinan tetapi juga membentangkan operasi pemesinan yang lebih mesra alam sekitar.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Machining is the process in which a tool removes material from the surface of a less resistant body, through relative movement and application of force. The material removed, called chip, slides on the face of tool, known as tool rake face, submitting it to high normal and shear stresses and, moreover, to a high coefficient of friction during chip formation. Most of the mechanical energy used to form the chip becomes heat, which generates high temperatures in the cutting region. Due to the fact that the higher the tool temperature, the faster it wears, the use of cutting fluids in machining processes has, as its main goal, the reduction of the cutting region temperature, either through lubrication reducing friction wear, or through cooling by conduction, or through a combination of these functions.

In recent time, many machining industries are try to achieve high quality, dimensional accuracy, surface finish, high production rate and cost saving product. Using turning process, large amount of cutting fluids is required and that caused the total cost of productions increased. When inappropriately handled, cutting fluids may damage soil and water resources, causing serious loss to the environment. Therefore, the handling and disposal of cutting fluids must obey rigid rules of environmental protection. On the shop floor, the machine operators may be affected by the bad effects of cutting fluids, such as by skin and breathing problems. Due to the technological innovations, machining without cutting fluid, such as dry machining, machining with MQL and cryogenic machining, is already possible, in some situations. However, it is important to remove cutting fluids from the process without harming productivity, tool life and work piece quality.

Technological evolution has provided some options for the use of cutting fluids in machining processes. Tool material properties have been improved and new tool materials have been developed in order to avoid or minimize the use of cutting fluids. Therefore, properties such as resistance against abrasion and diffusion, hot hardness and ductility have been greatly improved with the new tool materials. Tool coatings have provided high hardness, low friction coefficient and chemical and thermal stability to the tool. Tool geometries have been optimized to better break chips and also to produce lower surface roughness values in the workpiece. New concepts of machine tool design have allowed machining speeds to become faster, and increased rigidity enables more severe cutting operations to be used.

In dry cutting operations, the friction and adhesion between chip and tool tend to be higher, which causes higher temperatures, higher wear rates and, consequently, shorter tool lives. Therefore, completely dry operation is not suitable for all processes and all materials especially hard materials. So, in this experiment, the optimum parameters have to be found out in order to achieve the desired surface roughness. In turning operation, there are a lot of parameters those could affect the surface roughness of the work piece, such as depth of cut, feed rate, cutting speed, operating temperature, material used, and so on.

Surface finish of the machined parts is one of the important criteria by which the success of a machining operation is judged. In addition, surface finish is also an important characteristic that may dominate the functional requirements of many component parts. A good surface finish component part has a lot of advantages compared to a bad surface finish component part. For example, in prevention of premature fatigue failure, the good surface finish is one of the necessary criteria. Besides that, good surface finish can improve corrosion resistance; reduce friction, wear and noise. Thus, the life of product or component part can be improved with good surface finish. In economy, a better and long-life product is always the choice of consumers.

1.2 PROJECT BACKGROUND

Currently, there is a wide-scale evaluation of the use of cutting fluids in machining. Industries are looking for ways to reduce the amount of lubricants in metal removing operations due to the ecological, economical and most importantly human health. Therefore, it is important to find a way to manufacture products using the sustainable methods and processes that minimize the use of cutting fluids in machining operations. In addition, it is essential to determine the optimal cutting conditions and parameters, while maintaining long tool life, acceptable surface finish and good part accuracy to achieve ecological and coolant less objective.

Lathe machine is the oldest machine tool that is still the most common used machine in the manufacturing industry to produce cylindrical parts. It is widely used in variety of manufacturing industries including automotive and aerospace sectors. Quality of surface plays a very important role in the performance of turning as good-quality turned surface is significant in improving fatigue strength, corrosion resistance, and creep life. Surface roughness also affects several functional attributes of parts, such as wearing, heat transmission, and ability of holding a lubricant, coating, or resisting fatigue. Nowadays, roughness plays a significant role in determining and evaluating the surface quality of a product as it affects the functional characteristic.

The product quality depends very much on surface roughness. Decrease of surface roughness quality also leads to decrease of product quality. In field of manufacture, especially in engineering, the surface finish quality can be a considerable importance that can affects the functioning of a component, and possibly its cost. Surface roughness has been receiving attention for many years in the machining industries. It is an important design feature in many situations, such as parts subject to fatigue loads, precision fits, and fastener holes and so on. In terms of tolerances, surface roughness imposes one of the most crucial constraints for the machines and cutting parameters selection in process planning.

In this project, mild steel AISI 1019 is turning with lathe machine. This experiment will be held in only dry conditions which mean there is no any lubricant applied to the work pieces during the operation. Three machine parameters are varies during this experiment, which are depth of cut, cutting speed and feed rate. STATISCA software is using in this experiment to contribute a set of random combination of parameters data.

1.3 PROBLEM STATEMENTS

The challenge of modern machining industries is mainly focused on the achievement of high quality, in terms of work part dimensional accuracy and surface finish, high production rate and cost saving, with a reduced environmental impact. In machining process, it is necessary to attain the desired surface quality in order to produce parts providing the required functions.

The surface quality can affects some mechanical properties of the product, such as wear resistance, corrosion resistance, friction and so on. By the way, surface finish quality is influenced by various parameters. It will be costly and time consuming to acquire the knowledge of appropriate cutting parameters. At this point, surface roughness prediction will be helpful, which is mostly based on cutting parameters and sometimes some other parameters on dry machining. The concept of dry machining which is no any lubrication and cutting fluid applied during the operation, has been suggested since a decade ago, as a means of addressing the issues of environmental intrusiveness and occupational hazards, associated with the airborne cutting fluid particles on factory shop floors.

The absence of cutting fluid also leads to economic benefits by way of saving lubricant costs and work piece, tool machine cleaning cycle time. Health problem is caused by the long-term exposure to cutting fluids and the environment problem is caused by inappropriate way to handle the cutting fluids. In order to eliminate the effect of cutting fluids, dry machining has become a reliable choice in machining of some materials. However, some engineering materials still require cutting fluid in their machining operations and this is because of the needed surface quality, tool life, and machining dimensional accuracy. Hence the implementation of machining without coolant will bring down the manufacturing cost but can cause tool wear problems and low surfaces finish. Minimum quantity of lubricant can cut of manufacturing cost and produce better surface finish than dry cutting.

1.4 PROJECT OBJECTIVE

The objective of this study is to optimize the cutting parameters those carry out the optimum surface roughness in dry turning operation on mild steel AISI 1019.

1.5 PROJECT SCOPES

a. No any lubricant and cutting fluid present during the turning operation.
b. Machining variables considered are cutting speed, depth of cut, and feed rate.
c. Turning operation is performed using conventional lathe machine, Pinacho S90 VS/180.
d. Material use to test is Mild steel AISI 1019.
e. Surface roughness of workpiece is analyzed by using Mahr S2 perthometer.
f. STATISTICA software is used to contribute a table of random combinations of all parameters.
g. The cutting tool inserts is cemented carbide and it is assumed sharp always.
h. The tool wear and vibration are not take into consideration.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is discusses on some literature studies related to the surface roughness of dry machining in turning operation. A large number of analytical and experimental studies on surface roughness related to turning operations have been conducted.

2.2 SURFACE ROUGHNESS

Turning, milling, grinding and all other machining processes impose characteristic irregularities on a part's surface. Additional factors such as cutting tool selection, machine tool condition, speeds, feeds, vibration and other environmental influences will further influence these irregularities (Albrecht A.B., 1956; Boubekri N., Schneider M. H., and Asfour S., 1992).

Roughness is essentially synonymous with tool marks. Every pass of a cutting tool leaves a groove of some width and depth. In the case of grinding, the individual abrasive granules on the wheel constitute millions of tiny cutting tools, each of which leaves a mark on the surface. Roughness plays an important role to determine how a real object interacts with its environment. Rough surfaces usually wear more quickly and have higher friction coefficients than smooth surfaces. Roughness is often a good predictor of the performance of a mechanical component, since irregularities in the surface may form nucleation sites for cracks or corrosion. Although roughness is usually undesirable, it is difficult and expensive to control in manufacturing. Decreasing the roughness of a surface will usually increase exponentially its manufacturing costs. This often results in a trade-off between the manufacturing cost of a component and its performance in application.

Surface roughness is used to determine and evaluate the quality of a product, is one of the major quality attributes of an end-milled product. In order to obtain better surface roughness, the proper setting of cutting parameters is crucial before the process take place. This good-quality milled surface significantly improves fatigue strength, corrosion resistance, or creep life. Thus, it is necessary to know how to control the machining parameters to produce a fine surface quality for these parts. The control factors for the machining parameters are spindle speed, feed rate and depth of cut and the uncontrollable factors such as tool diameter, tool chip and tool wear.

The quality of machined components is evaluated by how closely they adhere to set product specifications of length, width, diameter, surface finish, and reflective properties. High speed turning operations, dimensional accuracy, tool wear, and quality of surface finish are three factors that manufacturers must be able to control (Lahidji, B., 1997). Among various process conditions, surface finish is central to determining the quality of a work piece (Coker, S. A., and Shin, Y. C., 1996).

Surface roughness is harder to attain and track than physical dimensions are, because relatively many factors affect surface roughness. Some of these factors can be controlled and some cannot. Controllable process parameters include feed, cutting speed, tool geometry, and tool setup (J.A. Arsecularatne, L.C. Zhang, C. Montross, and P. Mathew, 2006; Y.K. Chou, H. Song, 2004). Other factors, such as tool, work piece and machine vibration, tool wear and degradation and work piece and tool material variability cannot be controlled as easily (Coker, S. A., and Shin, Y. C., 1996).

The surface of a turned part has grooves produced by the corner of the cutting tool insert. The groove depth is a function of the corner radius and the feed per revolution, fpr. A reduction in fpr or an increase in corner radius will improve the obtained surface finish so much for that theory.

Unfortunately in practice it doesn't work that easily. There are a few more items which come into play: built-up edge, insert wear, turning speed, spindle bearing accuracy, and machine and part rigidity. Last, but not least, the type of steel and metallurgical structure has a great influence on the surface finish that can be obtained. The lead angle and chip breaker form has to be chosen to prevent the chip from running over the turned surface and damaging it.

The built-up edge (BUE) can be avoided with increased surface speed especially on steels with low carbon content, like AISI 1010, 1015 and 1115. Speeds up to 1200 sfpm can be used with coated carbide. Where a coolant is used, it should be directed underneath the cutting tool under pressure. On the top, the flowing chip acts like an umbrella and the coolant can't reach the point on the cutting insert where the material is separated. Changing to a cermet insert instead of carbide will also reduce the BUE formation.

Insert wear, depending on where it occurs, has an influence on surface finish. Flank wear has the biggest influence. Cratering is negligible as long as the crater does not reach the cutting edge. And a side notch caused by scale is usually far enough away from the nose radius not to have an influence on part finish. Higher surface speed with the same feed per revolution improves the part finish in many different steels.

The spindle bearings, preload and ball screw condition are others factors which influence the surface finish. The metallurgical structure of the steel can also play havoc with the finish.

2.3 FACTORS AFFECTING SURFACE ROUGHNESS

2.3.1 Nose Radius

Nose radius is a major factor that affects surface roughness. A larger nose radius produces a smoother surface at lower feed rates and a higher cutting speed (M.A. Yallese, K. Chaoui, N. Zeghib, and L. Boulanouar, 2009). However, a larger nose radius reduces damping at higher cutting speeds, thereby contributing to a rougher surface. The material side flow can be better defined when using a large nose radius. Again, this can be explained by studying the effect of the nose radius on the chip formation.

During cutting with a tool that has a large nose radius, a large part of the chip will have a chip thickness less than the minimum chip thickness value. In addition, increasing the nose radius has a direct effect on cutting forces, leading to a significant increase in the ploughing effect in the cutting zone. Increasing the ploughing effect leads to more material side flow on the machined surface. In general, increasing the nose radius increases the level of tool flank wear. Cutting with a large nose radius will result in higher value of cutting forces due to the thrust force component. On the other hand, cutting with a small nose radius prolongs tool life, which can be explained by the reduction in the ploughing force. Edge preparation has an effect on the surface roughness. Although the chamfered tool is recommended to prevent the chipping of the cutting edge, there is no significant difference in the rate of tool wear. The surface finish generally degrades with cutting time due to tool wear development.

Large nose radius tools have, along the whole cutting period, slightly better surface finish than small nose radius tools. Tool wear development with cutting time showed, after high initial wear rate, which flank wear land width increases in a linear way. The tool nose radii in the range of 0.8–2.4 [mm] seem to have no effect on the tool wear process, showing comparable wear rate and similar tool life.

2.3.2 Cutting Speed

Cutting speed has no major impact on surface roughness. It affects the surface roughness when operating at lower feed rates, which leads to the formation of a built up edge. Higher speeds are important in yielding accurate results. At speeds higher than 300 feet per second, actual surface roughness comes closer to the calculated value of surface roughness.

2.3.3 Depth of Cut

The depth of cut has a proven effect on tool life and cutting forces; it has no significant effect on surface roughness except when a small tool is used (Albrecht A.B. ,1956; Olsen K.V., 1968). Therefore, a larger depth of cut can be used to save machining time when machining small quantities of workpieces. On the other hand, combining a low depth of cut with a higher cutting speed prevents the formation of a built-up edge, thereby aiding the process by yielding a better surface finish (Axinite, R.C. Dewes, 2002; Hasegawa M., Seireg A. and Lindberg R.A., 1976; Taraman K., 1974).

2.3.4 Feed Rate

Feed rate is another major factor that has a direct impact on surface roughness. Surface roughness is directly proportional to the feed rate. The feed rate produces effective results when combined with a larger nose radius, higher cutting speed, and a smaller cutting edge angle (M.A. Yallese, K. Chaoui, N. Zeghib, and L. Boulanouar, 2009). Regarding the workpiece machined with a smaller feed rate, the machined surface shows that extensive material side plastic flow existed. This explains the better surface finish obtained at lower feed rates. A lower feed rate increased the area in which the chip thickness was lower than the minimum chip thickness, t_{min}. Hence, instead of cutting, a large part of the material was ploughed, which led to material side flow.

2.3.5 Build-Up Edge (BUE)

A built-up edge (BUE) usually forms at the tip of the tool cutting edge during machining. As the BUE becomes larger, it becomes unstable and eventually breaks up. The BUE is partly carried away by the chip; the rest is deposited on the work surface. The process of BUE formation is continuous, and destruction is continuous. It is one of the factors that adversely affect surface roughness. Although a thin stable BUE that protects the tool"s surface is desirable, BUE is generally undesirable. BUE does not form at higher cutting speeds, low depth of cuts, and higher rake angles.

2.3.6 Material Side Flow

One of the factors that deteriorate the machined surface is the material side flow. It is defined as the displacement of a workpiece material in a direction opposite to the feed direction, such that burrs form on the feed mark ridges. Workpiece material in the cutting zone is subjected to a high enough temperature and pressure to cause a complete plastification of the workpiece material. Chip material flow in a direction perpendicular to that of the usual chip flow during the machining of hardened steel has been observed. This material sticks on the new machined surface and causes a deterioration of the machined surface quality, even if the surface roughness is kept within the desired tolerance. In addition, the adhered material is hard and abrasive, such that it wears on any surface that comes into contact with the machined surface.

The surface deterioration is mainly attributed to material side flow that existed on the machined surface as a result of machining with a worn tool. In addition, the cutting speed has a significant influence on material side flow. The high temperature generated during high speed machining facilitates the material plastification and, therefore, causes a tendency for more material side flow.

2.3.7 Chip Morphology

An increase in the nose radius increases the chip edge serration; the chip edge serration can be explained by the reduction in the actual chip thickness near the trailing edge. Since the chip formation takes place mainly along the nose radius, it is expected that the chip thickness varies along the cutting edge.

Due to the nose radius, the chip thickness is decreased gradually to zero, causing high pressure at the trailing edge. Thus, the material at the trailing edge of the tool, where the chip thickness is a minimum, is subjected to high stress that causes tearing on the weakest edge of the chip.

In addition, the variation in the chip velocity facilitates the non-uniform displacement along the chip width, which leads to chip edge serration. The existence of the chip edge serration facilitates trailing edge wear. Grooves are worn in the tool at the positions where the chip edge moves over the tool. These grooves deteriorate the surface roughness and, in turn, reduce the tool life.

2.4 MACHINING CONDITION

2.4.1 Dry Machining

Dry machining is elimination on the use of cutting fluid. The interest in dry machining is often related to the low cost, healthy issues and environmentally friendly (P.S. Sreejith and B.K.A. Ngoi, 2000). Dry machining requires less power. However, they are sometimes less effective. This is because in dry machining higher order friction between tool and work and between tool and chip can lead to high temperature in the machining zone. This high temperature at the machining zone will ultimately cause dimensional inaccuracies for the work piece and too wear problems and also produce less surface finish.

Dry machining is ecologically desirable and it will be considered as a necessity for manufacturing enterprises in the near future. Industries will be compelled to consider dry machining to enforce environmental protection laws for occupational safety and health regulations. The advantages of dry machining include: non-pollution of the atmosphere (or water); no residue on the dwarf which will be reacted in reduced disposal and cleaning costs; no danger to health; and it is non-injurious to skin and is allergy free. Moreover, it offers cost reduction in machining (Narutaki, N., Yamane, Y., Tashima, S. and Kuroki, H., 1997).

Recently, dry machining is gaining popularity due to the increase in concerns regarding the safety of machinists and the environment. Dry machining helps in reducing the manufacturing costs. However, the implementation of dry machining cannot be accomplished by simply turning off the cutting fluid supply. It needs the usage of hard, wear resistant, low thermal diffusivity tool materials and coatings that can retain their properties at higher machining temperatures. Dry or green machining is stated to be environmental friendly as it does not pollute the atmosphere. It does not cause any health hazards to the people involved in this environment .It also helps in reducing disposal and cleaning cost. The absence of a coolant results in increase in machining temperatures and friction between the tool and the chips generated. This can cause forming of a built-up edge on the cutting tool. Transportation of chips also becomes difficult.

The various possible routes to achieve clean machining processes were analyzed and discussed by Byrne, 1993 (G. Byrne, E. Scholta, 1993). Elimination on the use of cutting fluids, if possible, can be a significant incentive. The costs connected with the use of cutting fluids are estimated to be many more times than the labor and overhead costs (F. Klocke and G. Eisennblatter, 1997; G. Byrne, E. Scholta, 1993). Hence the implementation of dry machining will reduce manufacturing costs. In the manufacturing industry, cutting fluids help to remove the heat generated due to friction during cutting to achieve better tool life, surface finish and dimensional tolerances to prevent the formation of built-up edge and to facilitate the transportation of chips. Coolants are 5essential in the machining of materials such as aluminium alloys and most stainless steels, which tend to adhere to the tool and cause a built-up edge. At the same time, the coolants produce problems in the working environment and also create problems in waste disposal. This creates a large number of ecological problems, but which in turn result in more economical overheads for manufacturing industries. If industries were to practice dry machining, then all of the above-mentioned problems should be addressed satisfactorily. The cutting fluid industries are reformulating new composites that are more environmental friendly and which do not contain Pb, S or Cl compounds.

Consumption of cutting fluids has been reduced considerably by using mist lubrication. However, mist in the industrial environment can have serious respiratory effects on the operator (A.S. Varadarajan, P.K. Philip, and B. Ramamoorthy, 2002; M. Sokovic and K. Mijanovic, 2001). The use of cutting fluids will be increasingly more expensive as stricter enforcement of new regulation and standards are imposed, leaving no alternative but to consider dry machining. Many metal-cutting processes have been developed and improved based on the availability of coolants. It is well known that coolants improve the tool life and tool performance to a great extent. In dry machining, there will be more friction and adhesion between the tool and the work piece, since they will be subjected to higher temperatures.

This will result in increased tool wear and hence reduction in tool life. Higher machining temperatures will produce ribbon-like chips and this will affect the form and dimensional accuracy of the machined surface. However, dry cutting also has some positive effects, such as reduction in thermal shock and hence improved tool life in an interrupted-cutting environment (J.R. Koelsch, 1992).

2.5 MACHINING PARAMETER

2.5.1 Cutting Speed

Speed always refers to the spindle and the work piece. When it is stated in revolutions per minute (RPM) it tells their rotating speed. But the important feature for a particular turning operation is the surface speed, or the speed at which the work piece material is moving past the cutting tool. It is simply the product of the rotating speed times the circumference of the work piece before the cut is started. It is expressed in meter per minute [*m/min*], and it refers only to the work piece. Every different diameter on a work piece will have a different cutting speed, even though the rotating speed remains the same.

$$v = \frac{\pi DN}{1000}[\mathrm{mmin}^{-1}] \tag{2.1}$$

Where, v is the cutting speed of turning in [m/min], D is the initial diameter of the work piece in [mm], and N is the spindle speed in [RPM].

2.5.2 Depth of Cut

Depth of cut is practically self-explanatory. It is the thickness of the layer being removed (in a single pass) from the work piece or the distance from the uncut surface of the work to the cut surface, expressed in mm. It is important to note, though, that the diameter of the work piece is reduced by two times the depth of cut because this layer is being removed from both sides of the work.

$$d_{cut} = \frac{D-d}{2}\,[\text{mm}] \tag{2.2}$$

Where, D and d represent initial and final diameter in [mm] of the job respectively. d_{cut} is represent the total diameter or depth in [mm] should be cut.

2.5.3 Feed rate

Feed always refers to the cutting tool, and it is the rate at which the tool advances along its cutting path. On most power-fed lathes, the feed rate is directly related to the spindle speed and is expressed in mm (of tool advance) per revolution (of the spindle), or [mm/rev].

$$F_m = fN\ [\text{mmmin}^{-1}] \tag{2.3}$$

Where, *Fm* is the feed in [mm/min], *f* is the feed in [mm/rev] and *N* is the spindle speed in [RPM].

2.6 LATHE MACHINE

The lathe is a one of the machine tools most well used by machining. It used principally for shaping pieces of metal and sometimes wood or other materials by causing the work piece to be held and rotated by the lathe while a tool bit is advanced into the work causing the cutting action. The basic lathe that was designed to cut cylindrical metal stock has been developed further to produce screw threads, tapered work, drilled holes, knurled surfaces, and crankshafts. In order to get an efficient process and beautiful surface at the lathe machining, it is important to adjust a rotating speed, a cutting depth and sending speed.

2.6.1 Basic Parts of Lathe Machine

In lathe machine, there are a lot of general or basic parts those are very important. Each component or part ash its own function and specifications. Basically the lathe machine has basic parts such as headstock, bed, carriage, tailstock, and so on.

2.6.2 Headstock

It contains the gears, pulleys, or a combination of both, which drives the workpiece and the feed units. The headstock contains also the motor, spindle speed selector, feed-unit selector and feed direction selector. It provides a means of support and rotation to the workpiece by attaching a work-holding device to its spindle. Headstocks have a hollow spindle to which work holding devices, such as chucks and collets, are attached, and long bars can be fed through for various turning operations.

2.6.3 Bed

It provides support for the other units of the lathe. V-shaped ways are located on the top of the bed providing alignment of the headstock, bed and tailstock. The top portion of the bed has two ways, with various cross-sections, that are hardened and machined accurately for wear resistance and dimensional accuracy during use.

2.6.4 Carriage

It slides along the ways and consists of an assembly of the cross-slide, tool post, and apron. The cutting tool is mounted on the tool post, usually with a compound rest that swivels for tool positioning and adjustment. The cross-slide moves in and out, thus controlling the radial position of the cutting tool, as in facing operations. The apron is equipped with mechanisms for both-manual and the cross-slide, by means of the lead screw.

2.6.5 Tailstock

It can slide along the ways and can be clamped at any position, supporting the other end of the work piece. It is equipped with a center that may be fixed (dead center), or it may be free to rotate with the work piece (live center). Drills and reamers can be mounted on the tailstock quill to produce axial holes in the work piece. A hand wheel allows for the extension of the tailstock spindle.

2.6.6 Feed Rod and Lead Screw

The feed rod is powered by a set of gears from the head stock It rotates during operation of the lathe and provides movement to the carriage and the cross-slide by means of gears, a fiction clutch, and a keyway along the length of the rod. The lead screw is used for cutting threads accurately. Closing a split nut around the lead screw engages it with the carriage.

2.6.7 Turning Process

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe, work piece, fixture, and cutting tool. Turning produces solids of revolution which can be tightly tolerance because of the specialized nature of the operation. Turning is performed on a machine called a lathe in which the tool is stationary and the part is rotated. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desired shape. Turning is used to produce rotational, typically axis symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners.

Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed. The work piece rotates in the lathe, with a certain spindle speed (n), at a certain number of revolutions per minute. In relation to the diameter of the work piece, at the point it is being machined, this will give rise to a cutting speed, or surface speed (Vc) in [m/min]. This is the speed at which the cutting edge machines the surface of the work piece and it is the speed at which the periphery of the cut diameter passes the cutting edge.

The cutting speed is only constant for as long as the spindle speed and/or part diameter remains the same. In a facing operation, where the tool is fed in towards the center, the cutting speed will change progressively if the work piece rotates at a fixed spindle speed. On most modern CNC-lathes, the spindle speed is increased as the tool moves in towards the center. For some of the cut, this makes up for the decreasing diameter but for very small diameters, and very close to the center, this compensation will be impractical as the speed range on machines is limited. Also if a work piece, as is often the case, has different diameters or is tapered or curved, the cutting speed should be taken into account along the variations.

The feed (f) in [mm/rev] is the movement of the tool in relation to the revolving work piece. This is a key value in determining the quality of the surface being machined and for ensuring that the chip formation is within the scope of the tool geometry. This value influences, not only how thick the chip is, but also how the chip forms against the insert geometry. The entering angle can be selected for accessibility and to enable the tool to machine in several feed directions, giving versatility and reducing the number of tools needed. Alternatively it can be made to provide the cutting edge with a larger corner and can add cutting edge strength by distributing machining pressure along a greater length of the cutting edge. It can also give strength to the tool at entry and exit of cut and it can direct forces to provide stability during the cut.

The cutting depth (ap) in mm is the difference between un-cut and cut surface. It is half of the difference between the uncut and cut diameter of the work piece. The